

Patch-Burn Grazing with Cattle as a Prairie Management Tool on Missouri Department of Conservation Lands

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Executive Summary

Tallgrass prairies, one of North America's most endangered ecosystems, evolved with fire, drought, and native grazers (bison and elk). In Missouri, over 99% of the original tallgrass prairie has been converted mainly to row-crop fields and tall fescue pastures. Concomitant with these landscape changes have been dramatic declines in the state endangered greater prairie-chicken and other grassland birds. Grassland ecologists in Kansas, Oklahoma, Missouri, and Iowa have been experimenting with a management practice known as patch-burn grazing with either cattle or bison since the late 1980s as a grazing system that benefits wildlife by emulating the presettlement disturbance regime.

Patch-burn grazing uses prescribed fire to manage the grazing behavior and distribution of grazers. A large body of research, including work completed recently by the Missouri Department of Conservation (MDC), demonstrably shows that patch-burn grazing with either cattle or bison results in improved habitat conditions and positive population responses for declining grassland obligate birds. Data also indicate that using patch-burn grazing with cattle (PBGC) with moderate stocking levels does not negatively impact native plant species diversity or floristic quality after 3-5 years of a PBGC rotation. Missouri Department of Conservation prairie wildlife biologists have observed that traditional MDC management of prairies focusing on just burning or haying or hay/burn rotations tended to promote uniform vegetation structure not optimal for the full suite of grassland bird habitat needs. Due to the dire situation with respect to the prairie-chicken, MDC has experimented with and adopted the use of PBGC on a subset of its prairies that are critical for nesting and brood rearing cover of the greater prairie-chicken and other grassland obligate birds.

Patch-burn grazing with cattle has been used on some Missouri prairies since 2001 and a four year replicated experiment has been conducted (2005-2008) involving five MDC prairies. While it is abundantly clear that PBGC benefits native grassland obligate birds, including the endangered greater prairie-chicken and northern bobwhite quail, the impacts of this management practice on individual plant species and insect species, stream water quality, soils, and small mammals are less understood. Little data are available on how PBGC impacts prairie streams. The effects of cattle access to stream health is dependent on several factors including stocking rates, grazing duration and season, vegetative composition, degree of shading in the riparian corridor, topography, and other factors. To date, cattle access to streams on MDC PBGC projects has been primarily limited to first order streams. It is still premature to declare what the long-term (10+) effects of PBGC are on prairie plant, insect, and small mammal communities in Missouri or what the impacts of the practice could be on prairie stream water quality.

MDC manages nearly 13,000 acres of remnant (unplowed) prairie on 64 different conservation areas statewide. In the growing season of 2009, MDC deployed patch-burn grazing with cattle on 11 prairie conservation areas (17% of the prairie conservation areas MDC manages). Current plans by the MDC prairie-chicken recovery team (October 2009) are to have PBGC used on 19 MDC prairies, with the best potential to provide habitat for grassland obligate birds in the near future (30% of the prairie sites MDC manages). For 2010, plans are to utilize patch-burn grazing on part of Taberville Prairie Natural Area, all of Niawathe Prairie Natural Area, and part of Pawnee Prairie Natural Area.

Because PBGC has many positive impacts to the prairie bird community with no apparent negative short-term (four years) impacts to the plant and butterfly communities, it is recommended that the practice is continued as an integral tool for MDC prairie management with specific cautions. Because significant unknowns still exist with respect to the impact of PBGC on streams and the long-term impacts to the plant community a conservative, cautious approach is recommended for using PBGC on MDC prairies. As part of this cautionary approach, stream protection (refer to the MDC Watershed and Riparian Management Guidelines), minimum rest periods, some limitations on deployment, limited long-term vegetation monitoring, and further stream impact studies are recommended for the continued use of PBGC on MDC prairies in the near future.

Fire, grazing, and mowing all have a part in prairie management. The tool-kit available to the prairie manager is broad and includes prescribed fire, haying, mowing, brush-hogging, herbicides, grazing, and seeding or planting. Add to these tools the variables of intensity, duration, season, spatial pattern and size of treatment area, and prairie management becomes extremely complex. All of these tools are needed at some point in the management of a large prairie remnant. Managers need the latitude to use their professional judgment when it comes to implementing and balancing the needs of management objectives.

Introduction

Tallgrass prairie is one of the most endangered ecosystems in Missouri (< 1% remains) and throughout North America (Samson and Knopf 1994). Periodic fires, droughts, and grazing by elk (*Cervus elaphus*) and bison (*Bison bison*) were the key drivers of the development of the tallgrass prairie ecosystem over the last 12,000 or more years (Axelrod 1985, Knapp et al. 1999, Sims and Risser 2000). The interaction between fire, grazing, and periodic droughts created a heterogeneous landscape of prairie natural communities in a variety of vegetation structural and compositional phases (Fuhlendorf and Engle 2001). Historically, bison and elk occurred in Missouri (Schwartz and Schwartz 2001). Bison are considered by many to be a “keystone” species of the tallgrass prairie, a species whose impact on the community is disproportionately large relative to its abundance (Knapp et al. 1999). A variety of sources agree that prairies require both fire and grazing to maintain the integrity of their plant and animal communities. Unfortunately, the ecological forces of bison, elk, and landscape fires have been gone from the tallgrass prairie biome for over a century and there are no good records of exactly how this interaction worked. In Missouri, bison and elk have been gone as a major ecologic force for over 150 years being replaced largely by domestic cattle and other livestock.

One result of the demise of the tallgrass prairie has been steep declines in grassland birds. In 1999, the greater prairie-chicken (*Tympanuchus cupido*) was listed as state endangered under the Missouri Wildlife Code because of continued steep declines in Missouri’s remnant population. In the same year the Missouri Grasslands Coalition was formed – a partnership of private and public entities aimed at restoring and conserving prairie wildlife with particular emphasis on the recovery of the greater prairie-chicken. Along with a variety of other conservation strategies the Missouri Department of Conservation (MDC) prairie wildlife biologists investigated whether grazing as a prairie management tool might benefit the greater prairie-chicken as well as other

declining grassland obligate bird species. It was not a new concept. Rangeland ecologists in Kansas and Oklahoma had been experimenting with using bison or domestic cattle (*Bos taurus*) in a grazing system known as patch-burn grazing since the late 1980s on tallgrass prairies. Research has shown that this patch-burn grazing system provides a mix of vegetation structure across a prairie landscape beneficial for the life history needs of grassland obligate bird species.

MDC prairie managers began experimenting with a patch-burn grazing system using cattle (PBGC) in 2001 on some MDC prairies (e.g., Stoney Point Prairie and Taberville Prairie Natural Area). MDC's Resource Science Division began a monitoring and evaluation project in 2005 to evaluate the impacts of PBGC on grassland birds, cattle production, vegetation composition and structure, and cattle behavior. The project was completed in 2008 and demonstrated significant positive effects for grassland bird species, no indication of negative effects to the plant community, and established the practice as economically viable for beef producers interested in both livestock and wildlife. Concurrent with this project, the 2006 MDC report, *Recommendations for Recovery of Greater Prairie-Chicken in Missouri (FY07-FY11)*, identified PBGC as an integral component of prairie management for greater prairie-chicken (GPC) recovery.

The adoption of PBGC as a prairie management tool for MDC-managed remnant (unplowed) prairies has not been without controversy. Significant concerns have been raised by botanists and plant ecologists with regards to the long-term impacts of PBGC on the plant community, especially rare plant species. Fisheries biologists have questioned the impacts of the practice on water quality and stream systems. Prairie enthusiasts who enjoy wildflower displays also were concerned about the aesthetic impacts of PBGC. This report is intended to help guide MDC administrators in making informed decisions regarding using PBGC as a prairie management tool and outlining future research needs. With that in mind the objectives of this report are to:

1. Summarize the current state of knowledge regarding PBGC.
2. Evaluate the use of PBGC within the context of the current understanding of tallgrass prairie ecology and management.
3. Provide a summary of the history of PBGC studies in the midwest.
4. Evaluate the impacts, both positive and negative, of PBGC to tallgrass prairie natural communities including native plants, aquatic biota, birds, terrestrial invertebrates, and soils.
5. Evaluate the use of PBGC relative to socio-economic factors.
6. Provide recommendations for further studies needed on PBGC in Missouri and other recommendations related to the above topics.

Bison versus Cattle

- Re-establishing bison grazing is impractical for all but the largest prairie remnants. For MDC-administered prairies, bison are not practical.
- Cattle, when managed with the patch-burn grazing system, can mimic bison foraging behavior.
- Cattle and bison have a high degree of dietary overlap when managed similarly.
- Cattle present a practical alternative to bison grazing to produce similar ecological effects of the historic native grazing – fire interaction regime.

The impracticality of bison and elk returning to our prairie remnants required managers to look for another alternative. Studies indicated that domestic cattle, when managed properly, can be suitable in simulating the historic grazing regime (Plumb and Dodd 1993, Fuhlendorf and Engle 2004, Towne et al. 2005). A primary concern when using cattle to mimic the impacts bison once imposed is the dietary similarities between cattle and bison. In a study comparing dietary overlap among two native and two domestic ungulates, Schwartz and Ellis (1981) found that overlap was relatively high among cattle and bison. Both species show a strong preference for graminoids, comprising more than 80% of their diets (Catchpole 1996, Hartnett et al 1997). Towne et al. (2005) compared trends in tallgrass prairie vegetation from 10 years of bison grazing, cattle grazing, and no grazing. They reported that plant communities in pastures grazed by bison and those grazed by cattle for 10 years were 85% similar in species composition. They also found the plant community similarity index between bison grazing and no grazing (62%) and cattle grazing and no grazing (67%) was much less than the similarity between bison and cattle grazing (85%). Both ungulates increased species diversity, and cover of annual forbs, perennial forbs, and cool-season graminoids. They grazed primarily grass with bison removing on average 54% of the annual net graminoid production compared with 46% removed by cattle. Residual forb biomass increased over time with bison and cattle grazing with no change in the ungrazed pastures.

Bison were found to be more specialized regarding forage class, focusing more on grasses, while cattle drew their food from a wider variety of available forage classes (Schwartz and Ellis 1981, Collins 1987). Towne et al. (2005) concluded that most measurable differences in vegetation trends of cattle and bison were relatively minor and that differences in the management of the species would play a larger role in their impact on prairie vegetation than differences between the species. Cattle are generally easy to acquire and manipulate, and are not associated with the financial, social, and safety issues pertaining to bison. While cattle do not pose identical impacts to prairie as do bison, they can present a better alternative than removing the grazing component from the grassland ecosystem.

The Patch-Burn Grazing System

Patch-burn grazing uses fire to control grazing distribution within a grazing unit (Alleger et al. 2006). A boundary fence is established around the grazing unit and then typically a third of the unit (a “patch”) is burned. Cattle are free to roam across the entire unit after the burn. A water source is provided in the grazing unit. The only interior fencing used is to fence off sensitive sites. The burning removes litter and stimulates the growth of vegetation in that patch. Cattle

preferentially graze the recently burned patch spending from two-thirds to three-quarters of their grazing time within the third of the pasture that had been burned that year (Fuhlendorf and Engle 2004, Fuhlendorf et al. 2006, Jamison and Underwood 2008) as the vegetation there is more palatable. This results in the creation of a short cropped patch or “grazing lawn” on the patch burned that year. In the following year another patch is burned and cattle focus their grazing efforts there. In years following burning, the patch recovers its vegetation height and litter to pre-burn levels. After three years the entire grazing unit has had a fire applied to it and the fire-grazing rotation is complete (Figure 1). At the end of three years the cycle can either begin again or a rest period or interval can be prescribed for the unit before implementing the rotation again. Season of burn, stocking rate of cattle, grazing season and duration, and cattle demographics (ages, sexes, breeds) are variables under a manager’s control. Typically moderate stocking and early spring (March) burns are utilized on MDC-managed areas. Both cow-calf and yearling (stocker) cattle can be used. Yearlings are less selective grazers in general (Provenza 2003) and, therefore, are less likely to target plant species considered to be highly palatable. Cattle are typically grazed from spring through summer, though some recent research includes year-round grazing. MDC prairies have been grazed from mid-April to mid-August (Jamison and Underwood 2008).

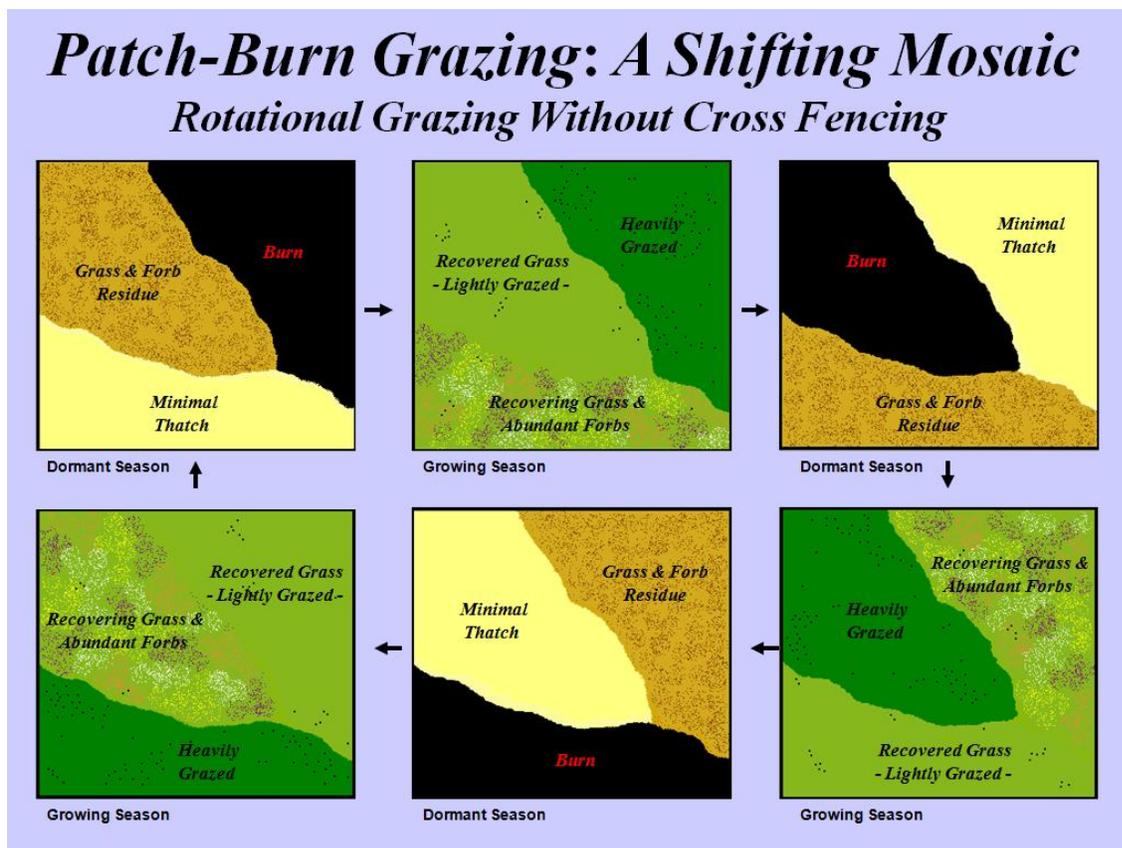


Figure 1. Diagram of the patches of a prairie in a patch-burn grazing rotation. Source: Randy Rogers, Kansas Wildlife and Parks.

Grazing Intensity (Stocking Rate)

- Stocking or grazing intensity and duration drives the impact to the vegetation.
- Appropriate stocking rate will result in the animals maintaining a grazing lawn in the recently burned patch with little forage consumption in the unburned patches.
- Overstocking generally causes undue grazing pressure on the vegetation and produces inferior wildlife habitat structure.

Grazing intensity and duration are key variables dictating the influence of livestock grazing on rangeland vegetation (Fuhlendorf and Engle 2001). A stocking rate too light will lessen the forage quality and attractiveness of the recently burned patch as the growing season progresses. The patch structure will, therefore, not be maintained. Overstocking will cause undue grazing pressure on the vegetation and also fail to maintain a patch structure as cattle are forced to seek forage beyond the recently burned patch. Rangeland scientists typically set a 50% utilization of annual aboveground net primary production (forage base) for moderate cattle grazing during the growing season (Hickman et al. 2004). Calculations for stocking levels of MDC prairies using patch-burn grazing for the monitoring and evaluation study (Jamison and Underwood 2008) were based upon actual forage production estimates (from hay removal information) on these prairies and utilized a slightly less than 50% utilization of annual forage production to account for drought. The stocking rate is determined for the entire grazing unit acreage, not just the patch burned that year. The MDC stocking rate is considered on the low end of the moderate range.

Ecological Impacts

Like any disturbance, be it fire, tree cutting, flooding, or grazing, there are negative and positive impacts to different groups of organisms. Improper grazing of prairies can reduce native plant species (Weaver 1954, Kucera 1956) and even bird species abundance and diversity (Robbins 2002). It is not the management treatment of cattle grazing itself but the key disturbance variables of grazing intensity, frequency, duration, pattern, and the interaction of grazing with other disturbances, especially fire, that determine whether cattle grazing has a positive or negative influence on native prairie biota.

Birds

- Different grassland bird species require different vegetation structures for their life history needs. Some species, such as the GPC, require a full suite of vegetation structures on the landscape. PBGC creates the entire vegetation structural gradient needed by grassland obligate birds (Table 1).
- PBGC increases vegetation structural heterogeneity and key vegetation structural attributes of importance to grassland bird species, including GPC and northern bobwhite.
- PBGC has definite positive impacts for true grassland bird species in terms of increasing densities or diversity in units with this treatment.
- Preliminary evidence indicates that PBGC creates the ideal grassland structure of nesting and brood-rearing habitat for the state endangered GPC.

Natural history studies have documented that different species of grassland birds have divergent habitat requirements for nesting, brood-rearing, foraging, mating, wintering, and loafing (Knopf 1996, Jacobs 2001, Powell 2006, Weir et al. 2007). The evolutionary importance of

heterogeneity in prairie is evident from the variability in grassland bird habitat requirements, with some species having affinities for grasslands with specific structural characteristics (Knopf 1996). For example, horned larks (*Eremophila alpestris*) prefer to nest in areas composed mostly of bare ground, whereas, at the other end of the spectrum, Henslow's sparrows (*Ammodramus henslowii*) prefer nesting in areas with high amounts of litter.

Table 1. Missouri Grassland Obligate Birds (Fitzgerald et al. 2000, Fitzgerald and Pashley 2000).

Greater Prairie-Chicken	<i>Tympanuchus cupido</i>
Henslow's Sparrow	<i>Ammodramus henslowii</i>
Dickcissel	<i>Spiza americana</i>
Bobolink	<i>Dolichonyx oryzivorus</i>
Grasshopper Sparrow	<i>Ammodramus savannarum</i>
Eastern Meadowlark	<i>Sturnella magna</i>
Upland Sandpiper	<i>Bartramia longicauda</i>
Northern Harrier (wintering)	<i>Circus cyaneus</i>
Short-eared Owls (wintering)	<i>Asio flammeus</i>

Birds - Vegetation Structure

The main influence of fire and grazing interaction is a temporary decrease in tallgrasses and an increase in forbs within the patch burned. This effect persists for approximately two years (Fuhlendorf and Engle 2004, Jamison and Underwood 2009). By three years following the initial patch fire, grasses again dominate and litter levels rebound to pre-burn levels increasing the chance of fire ignition and spread (Fuhlendorf and Engle 2004). As stated before, grassland bird species require critical components of vegetation structure and the juxtaposition of this structure. Maintaining a full suite of grassland bird species requires a mosaic of vegetation structure on a suitably sized grassland landscape. Traditional management practices (haying and burning) tend to create homogeneous vegetation structure and disturbance effects are relatively short-lived when viewed across Missouri's long and mesic growing season (Jamison and Underwood 2008).

PBGC increases vegetation structural heterogeneity in terms of the standard deviation of measurements of vegetation height, bare ground, litter, forb cover, and grass cover across prairie pastures (Fuhlendorf and Engle 2004, Jamison and Underwood 2008). PBGC created greater heterogeneity in litter depth, height, and density of grassland cover than spring prescribed fire alone (Jamison and Underwood 2008). The PBGC treatment substantially lowered mean percent cover obstruction at 0-4 inches and 5-8 inches (important GPC and northern bobwhite brood rearing variables) and mean maximum vegetation height (important GPC nesting variable) in recent year burned patches. After two years of management with PBGC (Jamison and Underwood 2008), structural diversity of these grasslands had increased greatly whereas control units receiving only spring burning were characterized by relatively uniform vegetation structure and height. The influence of grazing was strongest in the patch burned the current year. Mean percent obstruction within the first 8 inches above ground was greater in control units than PBGC units after a complete three year burn rotation. PBGC controls litter accumulation for two

or more growing seasons following a burn – extending the effects of a prescribed burn (Jamison and Underwood 2008).

Birds – Population Responses

Fuhlendorf et al. (2006) found that PBGC created the entire gradient of structure needed to maintain a suite of grassland bird species that differ in habitat preferences from upland sandpiper on patches with recent burning and heavy grazing to eastern meadowlark in patches of intermediate recovery from burning and grazing to Henslow’s sparrow in unburned patches two years post-burn that are barely grazed. The PBGC study on MDC-administered prairies (Jamison and Underwood 2008, Stroppel 2009) found the same result as illustrated in Figure 2 and discussed below.

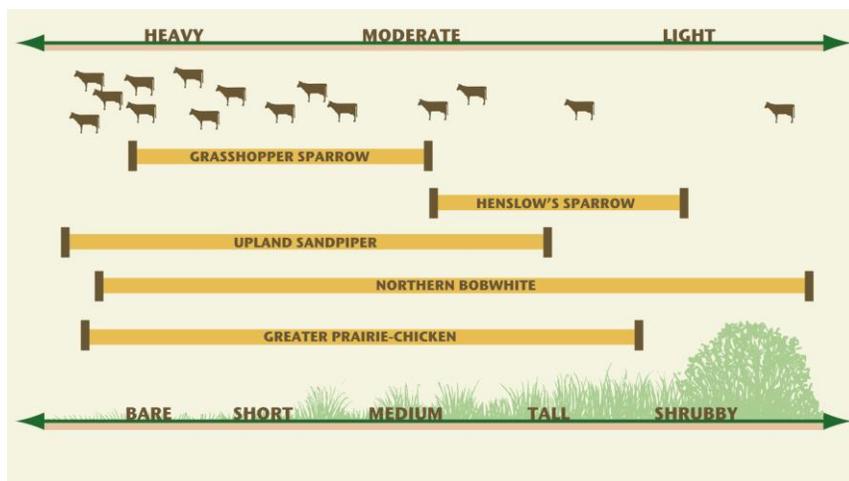


Figure 2. Range of vegetation structure provided by patch-burn grazing depending on year of burn (heavy to light grazing) and bird species response. Source: MDC.

Bird species richness was greater in PBGC units than in control (burn-only) units (Jamison and Underwood 2008, Stroppel 2009). The upland sandpiper, horned lark, greater prairie-chicken, and scissor-tailed flycatcher (*Tyrannus forficatus*) occurred frequently on PBGC sites, but only rarely (<3 observations) on control units (burn only). Jamison and Underwood (2008) and Stroppel (2009) found that dickcissel and Henslow’s sparrow densities were higher in the control units (burn only) while eastern meadowlark and grasshopper sparrow densities were higher in the PBGC units, a result consistent with findings from a patch-burn grazing study using bison (Powell 2006). Grasshopper sparrows strongly preferred the recently burned (and grazed) patches (Jamison and Underwood 2008). Henslow’s sparrow was absent from the recently burned and grazed patches but showed moderate densities in the other patches within the grazing units (Stroppel 2009), contrary to what would be expected based upon earlier habitat studies of this species (Burhans 2002).

Greater Prairie-Chicken Biology

In 2009 fewer than 300 prairie-chickens were known in Missouri (Jamison 2009). The situation for the continued persistence of GPC in Missouri is challenging and dire. The loss of suitable grassland habitat is the overwhelming factor responsible for population declines and range contraction of GPC (Svedarsky et al. 2000). GPC nesting success and brood survival are key demographic parameters – management should focus on optimal nesting and brood-rearing cover (Alleger et al. 2006). Nesting habitat should comprise two thirds to three quarters of the available grassland area. GPC hens prefer to nest in residual vegetation 12-15 inches tall up to 31 inches (Hamerstrom et al. 1957, Prose 1985, Svedarsky et al. 2000, Walk 2004). Nests in cover with < 25% litter are more successful (McKee 1995). Brood-rearing habitat is also crucial and should be in close proximity to nesting habitat. GPC chicks, like northern bobwhite chicks, are precocial and require habitat that is open at ground level with bare ground, abundant insects, and overhead cover 10-15 inches tall. The interspersed nesting and brood-rearing habitat or the amount of “soft edge” is an important feature for GPC habitat. PBGC provides appropriate nesting and brood-rearing vegetation structure for GPC as just described. Winter habitat includes native grasses for cover and nearby crop fields with waste grains for high energy food. Previous work in Missouri (Skinner et al. 1984) and Illinois (Walk 2004) indicated grazing provided habitat structure favorable for GPC. Continued radio telemetry work at MDC’s Taberville Prairie and The Nature Conservancy’s Wah’Kon-Tah Prairie (managed by MDC) has shown that GPC appears to prefer the PBGC units (Jamison 2009). Most GPC nests in 2008-09 occurred on recent PBGC units. Work in the Flint Hills has shown the positive effects of PBGC for prairie-chickens as well (Fuhlendorf et al. 2006).

Plants

- Patch-burn grazing with either cattle or bison typically suppresses the dominance of the major native warm-season grasses and, thereby, allows for an increase in cover of predominantly native annual forbs, perennial forbs, and cool-season grasses and sedges.
- Patch-burn grazing with either cattle or bison typically increases plant species richness and diversity indices. Jamison and Underwood 2008 showed no significant differences in plant species richness, diversity, or floristic quality between grazed and ungrazed plots after a three-year PBGC rotation in MO.
- Towne et al. (2005) examined the effects of moderate cattle grazing on native prairie vegetation managed with spring fires in a controlled experiment and that impacts on plant species with moderate grazing and fire varied from conventional predictions.
- If PBGC is used with an integrated sericea control program, control of sericea may be enhanced on PBGC managed prairies over prairies managed with fire alone (Hamilton 2010), but this requires further study.
- Grazers can transport seeds of exotic species through hooves, hair and defecation. Releasing cattle on a prairie from mid-April through summer greatly reduces their exposure to seeds of exotic species in the months prior to their release. This mitigates the risk of cattle accidentally introducing exotic species. Accidental introduction of exotic species seed by farm equipment used for haying and mowing may be a greater risk
- PBGC is not effective at controlling dense stands of winged sumac on its own (Cooper; Hedges 2009).

Plant responses to herbivory vary based on the timing and frequency of defoliation, the type of herbivore, plant parts consumed, the intensity of plant competition, and resources available to the defoliated plant. Plant species that have co-evolved with native grazers tend to have adaptive mechanisms allowing plants to persist and reproduce in the face of grazing pressures. For example, many prairie plants are long-lived perennials with extensive root systems that allow them to withstand droughts by storing water and tapping deeper water sources as well as to store energy to recover from herbivory (Coughenour 1985, Damhoureyeh and Hartnett 2002). Some species avoid grazing impacts by producing flowers close to ground level or with protective structures that prevent or deter consumption. Other prairie plants are annuals that require the increased sunlight, bare ground, and dampened plant competition created by ungulate grazers. Grazing animals can, therefore, modify competitive interactions in grasslands to allow annuals and other early successional plants to persist (Anderson and Briske 1995).

For decades rangeland ecologists and botanists have described plant species as increasing or decreasing in response to cattle grazing. A number of early plant ecology studies focused on the negative effects of heavy (overstocked) cattle grazing on prairie remnants (Drew 1947, Weaver 1954, Kucera 1956, Brotherson and Landers 1978). Note, however, that these early studies were looking at the effects of grazing only (not the grazing and fire interaction) where stocking rate and duration was heavily based on maximizing beef production. Plants determined to increase or decrease under heavy and uniform grazing pressure should not be assumed to have the same response under PBGC management. Destructive effects have been imposed by overgrazing cattle on native grasslands not previously subjected to that type, intensity, or frequency of disturbance (Drew 1947, Kucera 1956). However, ecological study has shown that it can also be a destructive practice to remove grazing from a system with a long grazing history (Hobbs and Huenneke 1992).

Vegetation Response – the MDC Study

Vegetation impacts of PBGC were investigated on five prairie remnants within Missouri (Jamison and Underwood 2008). The study tested PBGC impacts to plant species richness, diversity, and floristic quality using paired grazed and ungrazed plots. Study sites were divided into three patches and stocked with yearling cattle at an approximate rate of 1 Animal Unit / 5.5 acres (an Animal Unit or AU is 1,000 pounds of a grazing animal) from mid-April to mid-August. Specific stocking rates were established based on the productivity of each site and the ability of the cattle to maintain a “grazing lawn.” One patch was burned each year from 2005-2007. Vegetation monitoring was conducted annually throughout the 3-year burn/grazing rotation and a final year in which the study sites were rested.

Analyses were conducted to determine differences between grazed and ungrazed plots regarding species richness, species diversity, and floristic quality. The Floristic Quality Index (FQI) quantifies the integrity of a community by accounting for the number of native species and the value of those plants as indicators of being dependent on remnant natural communities (Ladd 1997, Taft et al. 2006). Greater FQI values suggest that more conservative plants (plants indicative of remnant, high-quality natural communities) are present. Diversity was analyzed using the Simpson and Shannon indices (Magurran 2004). These statistics consider the variety and abundance of species within the community. Greater diversity index (Simpson or Shannon)

values indicate greater species richness and a more even distribution in the abundance of those species as opposed to an area with the same number of species but having a few very abundant species and most relatively uncommon.

Following three years of PBGC and one year of rest, no differences were detected in species richness, diversity, or floristic quality (Figure 3) in the grazed vs. the paired ungrazed plots. There were annual fluctuations in species richness and floristic quality. The plots that were burned and intensively grazed in 2005 and 2006 had fewer species and lower floristic quality the year of the burn than their paired enclosure plots. However, these differences were not statistically significant. These reductions were temporary and were not detected during the next sampling year. This initial decline was likely not due to the loss of species, but because the plants were grazed and some species may have been undetected that year. A temporary decline was not detected in the 2007 burn patch. Precipitation data show that the growing seasons of 2005 and 2006 were extremely dry whereas 2007 and 2008 had above normal rainfall. Therefore, adequate rainfall may prevent any short-term decline in species richness and floristic quality.

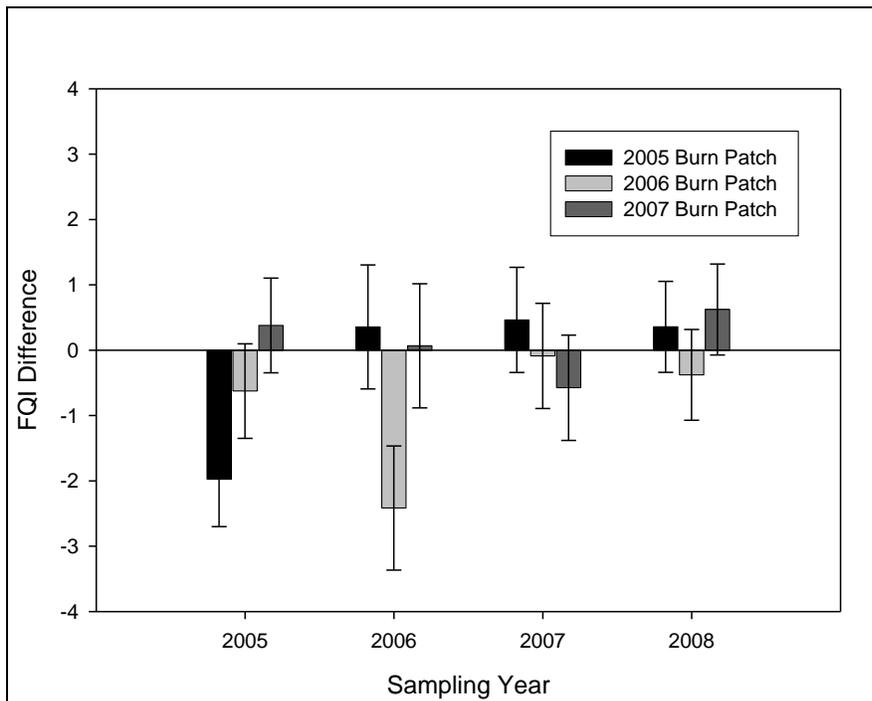


Figure 3. Average difference in FQI between paired grazed plots and enclosures. A positive value indicates a greater FQI in grazed plots and a negative value indicates a greater FQI in enclosures. Bars indicate standard error. Source: Jamison and Underwood 2008.

Other Studies of Vegetation Response

While the Jamison and Underwood (2008) study found no indication that grazing impacted the vegetation composition, other studies have reported increases in species diversity and richness following fire and grazing – these studies include both bison and cattle patch-burn grazing

projects (Collins and Barber 1985, Collins 1987, Hartnett et al. 1996, Collins et al. 1998, Hickman et al. 2004, Brudvig et al. 2007, Burns et al. 2009). Collins (1987) reported that species diversity increased following fire and bison grazing primarily due to a function of evenness rather than an increase in richness. This indicates that species diversity improved primarily because less abundant species increased while more dominant species decreased. Grazing and fire treatments reduced cover of a dominant prairie grass, big bluestem (*Andropogon gerardii*), by 27% (Collins 1987). Reducing the competition of dominant perennial grasses allows greater abundance and richness of other functional groups. Research supports that perennial and annual forb species have benefited from fire and grazing (Collins 1987, Fahnestock and Knapp 1994, Augustine and McNaughton 1998, Collins et al. 1998, Coppedge et al. 1998, Hayes and Holl 2003).

Additional nitrogen (N) supplied by grazers is likely a key element for plants to recover following grazing, and the grazing itself impacts how plants respond to additional N. Without grazers, an increase in N increases productivity and decreases species richness, while greater N associated with grazing increases productivity as well as species richness (Collins et al. 1998).

A few recent studies have examined the response of individual species to grazing impacts from cattle and or bison using the patch-burn grazing system. Hartnett et al. (1996) found that bison patch-burn grazing decreased the cover of big bluestem, Indian grass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) while increasing the cover of side-oats grama (*Bouteloua curtipendula*) and cool season-grasses (native and exotic). Lead plant (*Amorpha canescens*), heath aster (*Symphyotricum ericoides*), false boneset (*Brickellia eupatoriodes*), western ragweed (*Ambrosia psilotstachya*), yellow wood sorrel (*Oxalis stricta*), prairie ground cherry (*Physalis pumila*), and hairy ruellia (*Ruellia humilis*) all increased in cover with bison grazing while Missouri goldenrod (*Solidago missouriensis*) decreased. Damhoureyeh and Hartnett (1997, 2002) found that bison at Konza Prairie avoided eating white sage (*Artemisia ludoviciana*), and that bison and cattle avoided eating western ironweed (*Vernonia baldwinii*), cream wild indigo (*Baptisia bracteata*), Missouri goldenrod, blue sage (*Salvia azurea*), and showy evening primrose (*Oenothera speciosa*). Helzer and Steuter (2005) found there was a large difference between two Nebraska remnant prairie sites managed with PBGC in the percentage of grazed purple prairie clover (*Dalea purpurea*), a conservative prairie forb. On the tract with a low stocking rate (1 AU / 16 acres) cattle grazed very few prairie clover plants in either the burned or unburned areas. On the tract with a high stocking rate (1 AU / 3 acres) there was a high percentage of prairie clover plants grazed within the burned portion of the site. Patch-burn grazing with cattle does not appear effective at controlling winged sumac (*Rhus copallina*) on its own (Cooper; Hedges 2009).

Towne et al. (2005) studied the vegetation trends in Flint Hills tallgrass prairie annually burned in April and grazed by moderate stocking of cattle for the growing season over a period of 10 years. Although not patch-burn grazing per se, this study provides important insight into the impacts of cattle grazing on prairie vegetation. Grazing increased the cover of annual forbs, perennial forbs, sedges, and cool-season grasses. Missouri goldenrod and heath aster were mainly responsible for the increased forb cover on the grazed pastures. Western ragweed, lead plant, blue sage, Missouri goldenrod, and heath aster all increased in cover on cattle grazed prairie pastures. The increase in lead plant cover on cattle grazed prairie units contradicts

literature stating that cattle grazing reduces lead plant. Also of note, purple and white prairie clovers (*Dalea purpurea*, *candida*), scurfy pea (*Psoraleidum tenuiflorum*), round-headed bush clover (*Lespedeza capitata*), and blue-eyed grass (*Sisyrinchium campestre*) all increased in frequency between 1995 and 2004 on the cattle grazed units. These are plants that have also been thought to decrease in the presence of grazers (Weaver 1954). Results of the Towne et al. (2005) study provide further indication that plants known to increase or decrease following relatively high grazing pressure will not have the same response following PBGC.

Exotic Plants

Herbel and Anderson (1959) found that repeated cattle grazing and trampling can open up space for the colonization and growth of less competitive native annual plant species and non-native annuals and weedy perennial species. Towne et al. (2005) found that moderate grazing provided niches for some ephemeral fire-sensitive exotic species. Increasing species richness with ungulate grazing can be undesirable if the increase in species is due to greater numbers of exotic species. In tallgrass prairie pastures near Stillwater, Oklahoma subjected to a patch-burn cattle grazing treatment, sericea lespedeza (*Lespedeza cuneata*) cover increased from 1999 to 2005 from 3% to 5%, far less than in prairie pastures managed with a traditional cattle grazing system (Cummings et al. 2007). Canopy cover of sericea was less in patches burned in summer than in patches burned in spring, consistent with other work on control of sericea lespedeza using different seasons of burning. Patchburn grazing reduced the rate of invasion by sericea in the recently burned patches by maintaining young, palatable sericea plants that were then grazed. The authors concluded that patch-burn grazing could play a role in an integrated invasive plant management strategy on rangelands.

Terrestrial Invertebrates

- Burning is potentially more detrimental to invertebrates than grazing as a management practice. Leaving unburned refugia is critical for prairie invertebrates. The general recommendation is not to burn more than 2/3 of a prairie remnant at one time.
- In Iowa, PBGC using a light stocking rate increased the overall abundance of prairie butterfly species. The regal fritillary, a Missouri species of conservation concern, benefited from PBGC while the Ottoe skipper, a Missouri species of conservation concern, did better with a burn-only management regime (Vogel et al. 2007).
- Initial (2006-2007) results of the surveys for regal fritillary during the MDC PBGC study found that burning eliminated overwintering fritillary larvae but burned patches were quickly recolonized by fritillaries in the unburned patches. No consistent trends or differences were found between grazed and ungrazed areas with regard to the regal fritillary in 2006-2007 (Murray et al. 2007).
- Final butterfly survey results from the MDC PBGC study (Jamison and Underwood 2008) have not been analyzed yet (Moranz 2010).

Repeated burning can eliminate invertebrate populations if adequate refugia (unburned areas) are not provided. That is why it is generally recommended that only a third to a half of a prairie remnant be burned in any one year (Panzer and Schwartz 2000) – to provide refugia for fire-sensitive prairie invertebrates. Heavy grazing or fire can both decrease the abundance of invertebrates in grasslands if refugia are not provided. Patch-burn grazing does provide

invertebrate refugia in the patches that are unburned and also only lightly grazed. A study by Engle et al. (2008) of invertebrate taxa response to patch-burn grazing in tallgrass prairie pastures near Stillwater, Oklahoma showed that total invertebrate biomass is reduced in the patch that is burned that year but that this biomass rebounds in these same patches 1-2 years following fire.

Grasshoppers are major herbivores of tallgrass prairie often consuming as much vegetation in a growing season as bison at Konza Prairie (Joern 2005). Grasshopper species diversity and abundance, including several species which are generally uncommon, were greater in bison grazed and burned units versus burn-only units at Konza Prairie (Joern 2005, Jonas and Joern 2007).

The prairie mole cricket (*Gryllotalpa major*) is a Missouri species of conservation concern (Missouri Natural Heritage Program 2010) inhabiting many MDC administered prairies. Prairie mole crickets are highly associated with unplowed, remnant prairies and typically are not found outside of them (Busby 1991, Vaughn et al. 1993). Research indicates that prairie mole crickets are absent or sparse in overgrazed prairie pastures, presumably from compaction effects on their burrows (Busby 1991, Vaughn et al. 1993). Prairie mole crickets seem to do best in prairie hay meadows or lightly grazed prairie pastures and are absent from crop fields. Little is really known about the prairie mole cricket's response to fire and grazing treatments (Vaughn et al. 1993).

The only published study to systematically examine the response of prairie butterfly populations to PBGC was completed by Vogel et al. (2007) in Iowa. Further studies examining the response of prairie butterfly species to PBGC are ongoing in Iowa (Debinski 2010). Vogel et al. (2007) found that total butterfly abundance was highest on prairies that were managed with burning and cattle grazing versus graze-only or burn-only treatments. Butterfly species diversity was highest on the burn-only prairie units. For habitat specialist butterfly species, the results were mixed. The regal fritillary (*Speyaria idalia*), a Missouri species of conservation concern (Missouri Natural Heritage Program 2010), was twice as abundant on either the grazed or the grazed and burned units versus the burn-only units. The Ottoe skipper (*Hesperia ottoe*), also a Missouri species of conservation concern, was seven times more abundant on burn-only prairie units compared to the burn and graze or graze-only units. Vogel et al. (2007) recommended using multiple types of prairie management to provide the different microhabitats utilized by different butterfly species.

Small Mammals

- Little data are available regarding the impact of PBGC on small mammals.
- Deer mice appear to clearly benefit from PBGC.
- The thirteen-lined ground squirrel may benefit from PBGC.
- The prairie vole and western harvest mouse may decline with PBGC.

Few studies have examined the effects of PBGC on the small mammal community. Matlock et al. (2001) found that annual spring burning at Konza Prairie favors deer mice (*Peromyscus maniculatus*). Deer mice also benefited from patch-burn grazing with either cattle or bison. Knapp et al. (1998) relate that grazing also appears to have a positive influence on the thirteen-

lined ground squirrel (*Spermophilus tridecemlineatus*). Both the prairie vole (*Microtus ochrogaster*) and western harvest mouse (*Reithrodontomys megalotis*) prefer heavy litter. These species are rare on recently burned areas whether grazed or not (Clubine 2009). However, Knapp et al. (1998) found that grazing seems to have a negative effect on prairie vole and western harvest mouse, likely due to litter removal effects.

Streams

- Improperly managed cattle grazing can have definite negative impacts to streams.
- Little information is available regarding the impacts of PBGC to stream systems or on tallgrass prairie stream ecology.
- Available data from native prairie watersheds grazed with cattle (growing season long) or bison (year-round) in the Flint Hills of Kansas show only moderate impacts to prairie stream water quality when livestock stocking rates are moderate. These streams had minimal shade from trees (Rizzo et al. 2003).
- Fencing streams to prevent cattle access and providing alternative water sources is recommended (MDC 2009). While no clear guidance currently exists on how far up in the watershed streams need to be fenced to protect water quality, fisheries and wildlife managers are expected to establish the need for fencing on a case by case basis based on site specific characteristics.
- The potential downsides of adding interior fencing to management units include increased habitat fragmentation, bird-fence collisions, potential grassland bird predator attraction, greater impact potential at cattle stream crossings, and increased labor and maintenance costs. These additional issues should be considered during on-site evaluations of stream fencing needs.
- Historically prairie headwater streams were primarily dominated by herbaceous and shrubby prairie vegetation and not trees (Dodds et al. 2004).
- Headwater streams are important interfaces between terrestrial and aquatic systems (Peterson et al. 2001) analogous to capillaries in lungs.

Cattle tend to seek out water and shade in riparian areas. Inappropriate cattle management can lead to trampling and overgrazing of streambanks, soil erosion, loss of streambank stability, and declining water quality (Trimble and Mendel 1995). By installing alternate water sources, fencing out riparian corridors, and providing alternate shade sources, the potential damage of livestock to streams can be mitigated (Byers et al. 2005).

The headwater reaches of tallgrass prairie streams were historically dominated by a riparian corridor of mainly perennial prairie vegetation and a riparian canopy of trees was typically not present until lower in the watershed (Dodds et al. 2004). Headwater prairie streams tend to be “harsh” systems with great fluctuations between drying and flooding. Streams in tallgrass prairie are an endangered natural community with few remaining intact examples. Small streams are critical interfaces between terrestrial habitats and downstream receiving waters (Peterson et al. 2001). It is accepted that for forested ecosystems and fescue-dominated riparian zones a woody component to the riparian vegetation is needed to provide resiliency to the stream ecosystem. No current scientific literature indicates that prairie headwater streams had anything but shrubs as the woody component of their riparian vegetation. Changes within the stream system downstream of headwater areas can lead to a headward extension and deepening of the stream

network. Therefore, a greater shrub component of the riparian vegetation of prairie headwater streams may be required to mitigate head cutting.

Tallgrass Prairie National Preserve in Chase County, Kansas (TPNP) was acquired in 1996 and an aquatic macroinvertebrate baseline survey was completed in 2001 (Rizzo et al. 2003). Prior to and during this study the TPNP was being managed with spring burns and growing season cattle grazing (the early-intensive grazing system, not patch-burn grazing). Cattle were not restricted from streams and very little woody cover was available along the headwater creeks. Both intermittent and perennial streams were sampled. On average the macroinvertebrate community and water chemistry data showed good water quality for the range of streams sampled at TPNP. However, the macroinvertebrate metrics most sensitive to organic enrichment did show occasional declines compared to baseline conditions that may have reflected the cumulative impacts of cattle grazing on these systems.

Fish community studies at the TPNP, from 2001 to 2004, found that the low order streams of the site supported a moderately diverse prairie fish community including the federally listed Topeka shiner (*Notropis topeka*), a characteristic prairie fish species (Peitz 2005). Most fish species sampled were considered intolerant to moderately tolerant of water quality impairment. The watersheds of these streams at the preserve are dominated by Flint Hills tallgrass prairie. The past management of the site had been annual spring burns followed by two-three months of high-stocking grazing (the early-intensive grazing system). Recently the preserve has shifted management to patch-burn grazing with cattle. Streams have been open to cattle access. The results of this study suggest that moderate cattle grazing on native prairie watersheds for limited durations may be compatible with maintaining the prairie stream fish community. However, further studies of the impacts of PBGC on prairie streams are needed.

While large native ungulate grazers, such as bison, were historically an integral part of tallgrass prairie ecology and may have had moderate effects on stream biota and chemistry, how well this is emulated by grazing cattle is still an open question (Dodds 2010). Research in Oklahoma suggests that moderate cattle densities have only modest effects on N transport in streams (Olness et al. 1975), and this is similar to the effects of bison (Dodds et al. 1996, Kemp and Dodds 2001). Nitrogen cycling rates in tallgrass prairie streams near moderate numbers of cattle are similar to those measured for prairie streams with modest numbers of bison (O'Brien et al. 2007). Research in the Central Plains indicates that downstream nutrient quality is dependent upon riparian characteristics of intermittent first-order streams (Dodds and Oakes 2006), so the potential for cattle to influence downstream water quality is substantial. Again, more studies are needed to examine the impacts of PBGC on prairie streams.

Soils

- Only one study has examined PBGC on prairie soils (Konza Prairie). PBGC increased soil nitrogen, phosphorus and organic matter levels and did not significantly erode soil depth (Walters and Martin 2003).
- Heavy cattle grazing can increase soil bulk density, reduce infiltration, and decrease soil organic matter (Bauer et al. 1987, Daniel et al. 2002).
- It is unknown what the effects of PBGC are on soil bulk density and infiltration rates.

- Light to moderate cattle grazing can increase soil organic matter and nitrogen levels (Hobbs et al. 1991, Steinauer and Collins 1995, Johnson and Matchett 2001, Hobbs 1996).

The stocking rate and duration of grazing are key considerations when looking at the influence of cattle on soil health. Milchunas and Lauenroth (1993) found that heavy grazing can increase bulk density of soil and decrease soil organic matter. They found that light to moderate grazing can increase soil organic matter and nitrogen levels. No consistent trends in soil pH were found. Only one published study has specifically examined impacts to soil from PBGC. This study by Walters and Martin (2003) at Konza Prairie found that PBGC did not significantly influence soil depth, while increasing soil nitrogen, phosphorus, and organic matter levels. No clear trends were evident in soil pH or moisture.

Rest Periods (Return Interval)

No “ideal” rest period between PBGC rotations has been identified (Engle 2010) and the use and duration of such a treatment should be driven by management objectives. For grassland birds the ideal rest period or return interval for returning a patch-burn cattle rotation might be two years. Two years of rest from grazing appears to be the amount of time it takes prairie vegetation structure to fully recover from the grazing effect (Fuhlendorf et al. 2006, Jamison and Underwood 2008, Clubine 2009). Resting a management unit from grazing for more than two growing seasons results in the loss of the ideal mix of vegetation structure for GPC and northern bobwhite and habitat for upland sandpiper and grasshopper sparrow. To maximize grassland bird habitat, only one growing season of rest may be recommended (Clubine 2009). There are no data on the ideal rest period to maintain: conservative prairie plant species, possibly sensitive insect species (i.e., prairie mole cricket), possibly sensitive stream biota, or acceptable soil bulk density values.

Other Grazing Systems

A wide variety of rotational grazing systems have been designed with each having slightly different characteristics. Each grazing system produces different effects on the ecosystem. Therefore comparisons of grazing impacts between systems can be difficult. Most conventional grazing systems attempt to maximize cattle weight gain and forage utilization, which is not the case for PBGC as used by MDC. In production grazing systems, stocking rates are set as high as possible without degrading the forage quality and quantity. Management intensive grazing (MiG) is a system typically recommended in Missouri where cattle are rotated among numerous pasture units dominated by tall fescue and managed uniformly. The goal is for cattle to evenly graze the entire pasture. Cattle are moved to another pasture when the vegetation height is reduced to a minimum level. High stock density on all paddocks throughout the nesting season make MiG detrimental to grassland wildlife.

Another production-oriented system is early intensive grazing (EIG) – also known as early intensive stocking (EIS). EIG utilizes annual spring burns and cattle stocking rates double that of year-round operations. Cattle are stocked on the prairie from May through mid-summer, often following a spring burn of the entire unit. The end result is a spatially homogeneous grassland

landscape that provides poor habitat for GPC and Henslow's sparrow (Robbins et al. 2002). This EIG system is used widely in the Flint Hills ecoregion and is creating negative impacts to the grassland bird community of this last stronghold of the tallgrass prairie ecosystem (With et al. 2008).

The more commodity-driven systems were described above so that managers understand the common cattle production systems used by livestock producers in the Midwest. The PBGC practiced on MDC grasslands is very different. PBGC uses an ecological model rather than an agricultural production model and has greatly different wildlife impacts.

Social and Economic Issues

Private Land Implications

- The average weight gain of 1.6 pounds per head per day on native prairies managed with PBGC is superior to what a Missouri producer may expect from endophyte-infected or even endophyte-free fescue during the summer months. Basically, PBGC makes economic sense during the summer months when the physiological impact of consuming endophyte-infected fescue is greatest upon the grazing animal (Alleger 2010).
- By demonstrating the economic effectiveness of PBGC on MDC managed prairies as part of a range management system, MDC can assist grassland wildlife if some producers adopt these practices. If private pasture management could be shifted to using wildlife-friendly cool-season grass/legume mixes and or native-warm season grass plantings or remnant prairie pastures managed with PBGC, then grassland birds would stand to greatly benefit.
- PBGC makes the most sense for those who lease grazing land because they receive the benefits of maximum summer weight gain without owning the land year-round; in other words they are maximizing gross productivity per animal. Graziers on MDC prairies fit this category. Landowners who must pay property taxes and mortgage interest on the land find PBGC less attractive. Despite superior summer weight gains, they can generally net more dollars per acre grazing exotic cool-season grasses.

Aesthetics

- No quantitative or even semi-quantitative survey results indicate how the Missouri public and key constituent and partner groups view PBGC on MDC prairies so it's difficult to make any definite statements about aesthetic costs and benefits of PBGC.
- With PBGC, the intensively grazed prairie patch (the patch that was most recently burned and receives the most grazing pressure) is not visually attractive, primarily during the latter part of the growing season. Other management practices such as burning and haying can also create landscape features that are temporarily unattractive.
- Wildflower displays can be dampened in the patch being most intensively grazed.
- Grazed fescue pastures are a common feature of Missouri's landscape. That may be an unfortunate image or stigma in the mind's eye of many prairie enthusiasts when they see cattle grazing on recently burned patches in a remnant prairie.

Native Seed Production

- No quantitative studies have examined the effects of PBGC on prairie plant seed production.
- Reduced seed production in grazed patches is a concern.

Recommendations

Continue to use PBGC as an integral prairie management tool on MDC managed prairies with these considerations:

Data Gaps

1.) Stream Impacts from Patch-Burn Grazing with Cattle

Complete the proposed seven year study “Ecological Integrity of Prairie Streams as Influenced by Patch-Burn Grazing and Riparian Protection” being investigated by Dr. Walter Dodds of Kansas State University, Dr. Matt Whiles of Southern Illinois University and their graduate students at Osage Prairie Conservation Area and Natural Area. First year pre-treatment data have already been acquired.

Lead: Resource Science.

2.) Additional Vegetation Monitoring of a Set of Prairies Managed with PBGC Integrated with other Management Tools

Investigate the feasibility and design of a long-term (10+ years) vegetation monitoring project to track trends in the biological integrity of the plant community at select prairie natural areas managed with patch-burn grazing along with the full complement of necessary prairie management tools (including altering burn season, herbicides, brush-hogging, mowing, haying, etc.). The objective of the monitoring would be to track trends in plant species composition, though the changes may not be able to be attributed to any single management treatment. The study would have specific management and sampling objectives with specific trigger points (or thresholds). If those thresholds are crossed, an evaluation of the prairie’s management practices would be initiated by a team of MDC biologists including the area manager.

Lead: Resource Science and Wildlife

3.) Impacts to Terrestrial Invertebrates, Small Mammals, and Soils

Little data are available on the impacts of PBGC to terrestrial invertebrates, small mammals, and soils. However, the data that are available do not indicate there should be any undue concern for the impacts of PBGC to these resources. This is currently a low priority for future MDC research.

Lead: Resource Science

4.) Scale of PBGC Management Units

No literature exists on the smallest appropriate sized management unit for PBGC. Management units under 100 acres in size might be too small because of practical constraints and the possibility of changes in cattle behavior (Weir et al. 2007). Managers should consider the scale and monitor cattle behavior to ensure that the cattle spend most of their grazing time on the most recently burned patch. There may also be considerations of the minimum patch scale usable for grassland birds.

Stream Protection

- Follow the “Watershed and Stream Management Guidelines for Lands and Waters Managed by the Missouri Department of Conservation” (MDC 2009).

Lead: Fisheries and Wildlife

Rest Period and Stocking Rate

“Rest period” is defined here as a rest from a grazing treatment, not necessarily an “idled” treatment. Rest period treatments and durations will vary depending on management objectives and site-specific conditions. After a two year rest period the vegetative structure ideal for the full suite of grassland birds is lost (Fuhlendorf and Engle 2004, Jamison and Underwood 2008). With a two year rest period between rotations, each patch within a grazing unit will have two years of light grazing followed by two years of no grazing. Until additional scientific evaluation provides further guidance, a minimum two-year rest period is currently recommended to minimize potential unknown negative impacts, to provide opportunity to address other management needs (e.g., woody or exotic species control), and to provide for other uses of the prairie (e.g., wildflower displays, seed harvest).

Continue to implement a moderate stocking rate typically set by rangeland scientists (50% utilization of the forage base within the grazing unit) where PBGC is used.

Lead: Wildlife

Balancing Multiple Uses of the Prairie

For the consideration of aesthetic and seed harvest concerns, grazing or burning the entire prairie area at one time is not encouraged. While not a recommendation, managers should consider leaving at least a third of the prairie ungrazed and unburned at any one time to provide an area for balancing aesthetic and seed harvest concerns with other management objectives as well as provide refugia for grazing and or fire-sensitive species.

Lead: Wildlife

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